Scope of works for Z1/Z2 tram upgrades

1. Vehicle Ride:

Ride problems identified in the Z1 tram during the commissioning of the first delivered vehicles. The problem relates to a poor bogie/suspension design. Investigations into the problem occurred during the initial delivery and a solution was incorporated into the vehicles delivered after car 79.

A modification was developed which converted the Z1 bogie into a Z2 bogie but a conversion program was never undertaken.

In addition to the original design deficiencies the Z1 and Z2 bogie suspensions and bogie attachments have worn.

Z2 performance can be achieved by undertaking the following work:

- fabrication of a new bolster*
- modification of bogie frame*
- installation of Z2 type clampers*
- installation of hour glass springs*
- replacement of all suspension rubbers
- machine and pack wear plates
- align bogie, wheels, bolster, traction motor axle boxes

* for Z1 cars only

Cost for Z1	=	$8,311	(80 cars)
Z2	=	$5,472	(34 cars)
Fleet cost	=	$1,288,688	

2. Gears

The specified working life of the Z1 gears is given as between 1,000,000 and 1,200,000 km. Under PTC operating conditions, the gears should be changed after 14 to 20 years. The Z1/Z2 fleet is now in that time range and it would be advisable to perform an exchange during the bogie upgrade given in section 1.

- uncouple from motor
- uncouple lay-rub coupling
- remove gear box/axle/axle boxes
- replace gears, pinions and bearings
- replace rubber components in coupler and reaction bolt
- reassemble
- fit to frame, pack, trim and align

Cost per car	$8,000
Cost per fleet	$912,000

3. Tramiac

The tramiac controls the powering and braking of the tram. This equipment has been subject to an increased failure rate (approximately one per week).

A more disturbing aspect is the increase of unrecoverable failures. During the last 12 months, 3 of the 6 rotative spares have been used to replace units which have been destroyed. The replacement cost for one replacement quoted by the supplier is $100,000. Tramiacs have been removed from storage cars at Hawthorn and fleet availability will be affected if action is not taken.

A modification program has been established which will reduce the possibility of failure and will also result in improved acceleration rates (better operator and customer ride).

- rebuild tramiac cards (20 off)
- modify circuiting
- adjust system
- refit system to vehicle

Cost per car	$5,000
Cost for fleet	$570,000

4. Pantograph Conversion

The maintenance and operating efficiencies of pantographs do not need to be explained as the Corporation has already made this decision. As the Z1 fleet will be in operation for a minimum of 15 more years, a pantograph conversion must be undertaken to ensure that these vehicles can operate throughout the system.

- manufacture frame work
- remove roof and replace with new section
- rewire 600 volt and related controls
- modify drivers consoles
- use an existing pole as an emergency pole
- high potential test of roof

Cost per car	$11,520
Cost for fleet	$1,313,280

5. Hazard Lights

OPTION 1 replace existing circuitry with new circuitry which allows flashing section

Cost per car	$300
Cost for fleet	$34,200

OPTION 2 installation of red flashing lights which operate when passengers are boarding and alighting from vehicles.

N.B. Composite modification used on car 67.

this modification can best be done during the pantograph conversion, whilst sections of the roof are off and the drivers console is being modified.

Cost per car	$15,000
Cost for fleet	$171,000

6. Line breaker and power contact overhauls

The line breakers and power contacts are due for major overhaul. The incidence of failure on these items is increasing and the number of severe or unrepairable failure is causing concern. Many of these items are obsolete and equivalents must be sourced. The cost of new items range up to $19,700 for the line beaker. The other disturbing factor is that the environment of these items is indusive to major faults, two recent line breaker faults have resulted in complete equipment case rebuilds which take the vehicle off the rails for up to 3 months.

- remove breakers/contactors, replace with overhauled uni
- strip down and clean
- replace contact tips
- check moving parts, replace non conforming items
- test mechanical and electrical components
- reassemble
- test completed unit

Cost per car	$4,046
Cost for fleet	$461,244

7. Resistor Boxes

- remove boxes
- clean
- check resistance valves
- check insulation
- replace non conforming items
- final check

Cost per car	$456
Cost for fleet	$51,984

8. Public Address System

The existing system does not work and should be replaced.

- purchase and install new public address unit
- install cabling and speakers
- install microphones and switches in consoles

Cost per car	$1,020
Cost for fleet	$116,280

9. Windscreens/Wipers

OPTION 1 replace windscreen and washer jets and standardise wiper mechanisms

Cost per car	$300
Cost for fleet	$34,200

N.B. Composite Option 1+2 arrangement on car 67

OPTION 2 Replace windscreens (possibly with tinted units)
Replace washer jets
Install vertical mount, large radius wipers, will require major changes in drivers cockpit.

Cost per car	$2,520
Cost for fleet	$287,280

10. Wiring inspection

To test and certify the electrical integrity of the car for safety and operating purposes.

- disconnect some wiring
- bridge out common wiring levels
- high potential test
- inspect cables and cable ducts
- reconnect cables

Cost per car	$1,300
Cost for fleet	$148,200

11. Heating System

To replace existing system with a unit which allows better heat distribution and variable temperature ranges for improved crew and passenger comfort.

- remove dump valves
- construct heaters (six of per car)
- remove nominated seats and ventilation ducts
- install heaters and cabling
- integrate into air delivery system
- replace seats and duct covers
- performance test

Cost per car	$8,000	
Cost for fleet	$800,000	(cars 1 to 100)

12. No Volt Relay

- remove old relay and replace

Cost per car	$200
Cost for fleet	$22,800

13. Motor Group Switches

The current assembly does not give a positive action and has been the source of problems in the field.

- remove old units
- replace with superior unit

Cost per car	$500
Cost for fleet	$57,000

14. Battery Boxes

The existing battery boxes are failing due to corrosion

- remove current battery boxes
- replace with stainless steel equivalents

Cost per car	$300
Cost for fleet	$34,200

15. Pump Unit

The pump unit is due for an overhaul. The majority of the units have been in operation for 15 years without major servicing.

? overhaul tasks not determined yet.

Estimated cost per car	$800
Estimated cost for fleet	$91,200

16. Windows/Seals

Most of the window seals have worn or moved resulting in water ingress which causes rushing of the interior sills.

- remove windows
- replace seal
- make good paint work
- replace window

Cost per car	$552
Cost for fleet	$62,928

17. Drivers Seats

There has been continued driver pressure to improve the seat on the older fleet. A seat allowing adjustments similar to that on the B2 tram is the ideal.

- remove old seat
- replace with new or modified units

Cost per car	$2,500
Cost for fleet	$285,000

("Grammer Brenshey" brand)

Summary of funds required to upgrade Z1 and Z2 tram cars.

	Per Car $	Fleet $
Vehicle Ride		
- primary suspension	5,472	623,808
- secondary suspension (before car 80	8,311	664,880
Gears		
- replace gears, pinions, bearing & overhaul couplers	8,000	912,000
Tramiac	5,000	570,000
Pantograph Conversion	11,520	1,313,280
Hazard Lights	300	34,200
Line breaker & power contact overhaul	4,046	461,244
Resistor Boxes	456	51,984
Public Address System	1,020	116,280
Windscreen/Wipers	2,520	287,280
Wiring inspection	1,300	148,200
Hearing system (before car 100)	8,000	800,000
No volt relay	200	22,800
Motor cut out switch	500	57,000
Battery boxes	300	34,200
Pump unit	800	91,200
*Windows/Seats	-	-
Drivers seats	2,500	285,000
Centre doorway mod	550	22,000
*Livery	-	-
*Re-upholster seats (change seat cushions only)	-	-
* A revised figure has been provided by PWS for these items	10,160	1,158,240
	-	
Total Fleet Cost		**$7,653,596**